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UTILITY PATENT APPLICATION

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INVENTION TITLE: Illuminating Devices Using Small PT Sources Including LEDs

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Sir:

Your applicant, named above, hereby petitions for grant of a utility patent to him or any assignee of record, at the time of issuance, for an invention more particularly described in the following specification and claims with the accompanying drawings, verified by the accompanying declaration and entitled:

Illuminating Devices Using Small PT Sources Including LEDs

Reference To Related Applications

The present application is based on and claims the priority of provisional application, Serial No. 60/440,495 filed January 16, 2003. The substance of that application is hereby incorporated herein by reference.

Field of Invention

The present invention relates generally to the lighting field, and, more particularly to creating planar illumination devices from which diffused light of signular or multicolored light can be derived.

Summary of Invention

The present invention provides planar illumination devices from which diffused light of singular or multicolored light can be derived.

It is another object of this invention to provide directionally controllable light that is projected from bendable planar illumination devices in order to change patterns of illumination.

It is another object of the invention that with the integration and introduction of electric control devices, the above-mentioned planar surfaces can be made to change/blend and create patterns of changing color.

It is another object of this invention to create planar illumination devices that project light onto architectural surfaces with controlled and varied beams, angles and light patterns.

It is another object of this invention to create linear illumination devices in the shape of bars, strips and rods of varied cross-sections that emit light along their lengths in evenly distributed or patterned illumination.

It is another object of the invention to create geometrically shaped illumination devices for decorative and general lighting products.

These and other objects, features and advantages will be apparent from the following detailed description of preferred embodiments taken in conjunction with the accompanying drawings in which:

Brief Descriptions of Figures

Figure 1 is a diagrammatic view illustrating a light transmission rod blending color from multiple LEDs.

Figure 1A is a diagrammatic view illustrating a variation of Figure 1 in which the surface of OR is textured.

Figure 1B is a diagrammatic view.

Figure 2 is a diagrammatic view which illustrates a means for blending color from multiple LEDs.

Figure 2A is a diagrammatic view which illustrates a variation of Figure 2.

Figure 2B is a diagrammatic view which shows a variation of Figure 2A.

Figure 2C is a three dimension diagram of a wedge shaped optical device for blending color from multiple LEDs.

Figure 2D shows a variation of Figure 2C.

Figure 2E shows a variation of Figure 2C and 2D.

Figure 2F shows a variation of Figure 2C, 2D, 2E and 2F.

Figure 2G shows a section view of Figures 2C, 2D, 2D, 2E and2F

Figure 3 illustrates a matrix of light blending rods.

Figure 4 is a three-dimensional view of an optical structure comprised of tapered bars.

Figure 5 is a graphic illustration of a matrix of tapered rods or bars.

Figure 6 is a three-dimensional illustration of an optical configuration for creating uniformly illuminated surfaces.

Figure 6A is a cross-section view of Figure 6.

Figure 6B is a three-dimensional diagram of an optical system for integrating the illumination from multiple LEDs.

Figure 6C is a sectional view of Figure 6B.

Figure 6D is an isometric view.

Figure 7 is a graphic diagram illustrating a group of LEDs projecting rays though a prismatic plate.

Figure 7A is a three-dimensional diagram of a row of LEDs and cylindrical lenses.

Figure 7B is a cross-section view of Figure 7A.

Figure 8 is a plan view of a disk like optical configuration.

Figure 8A is a cross-section view of Figure 8.

Figure 8B is a variation of Figure 8.

Figure 8C is a variation of Figure 8.

Figure 8D is a diagrammatic view of an optical system.

Figure 8E is a diagrammatic view showing hexagonal disks.

Figure 9 is a cross-section view of an optical grid.

Figure 9A is an enlarged view of a portion of Figure 9.

Figure 9B is an optical light emitting source similar to that of Figure 9.

Figure 9C is a graphic representation of a plan view of Figures 9, 9A, and 9B.

Figure 10 is a three dimensional diagram of an optical guide.

Figure 10A is a partial cross-section view of Figure 10.

Figure 10B illustrates a modification of 10A

Figure 10C is a cross-section view of Figure 10, 10A and 10B.

Figure 11 is a cross-section diagram of a light emitting optical structure.

Figure 11A is a cross-section diagram of a tubular structure.

Figure 11B is a cross-section view of a bundle of LEDs.

Detailed Description of the Drawings

FIG 1 illustrates a means for mixing and blending light from multiple light sources producing different wavelengths of light. The means shown in FIG 1 is comprised of three light projecting LEDs, LED R, LED Y, and LED B projecting red, yellow, and blue light respectively. LED R, LED Y and LED B are arranged to project light into the entry

face of the optical transmission rod OR. Light from each LED traveling through OR is multiply reflected by total internal reflections (T.I.R) and exits through exit face EX as blended light RARYB. Any or all of the LEDs, LED R, LED Y or LED B can be illuminated at any one time and at any ratio of brightness to blend colors of various hues and brightnesses. The same is true for all FIGs having multiple LEDs of varied colors. For graphic and descriptive purposes three LEDs have been shown.

FIG 1A illustrates a similar optical configuration as FIG 1, differing in that the surface of OR is textured, causing the light from LED, LED Y and LED B to be diffused along the pathway of and from the surface of the transmission tube or rod OR.

FIG 2 illustrates a means for mixing and blending light by projecting light from multiple colored LEDs, LED R, LED Y and LED B, into the entry face of a tapered optical structure TOS - the type and composition of such structures are described in my U.S. patents Nos. 5,046,805 and 6,540,382, the substance of which is incorporated herein by reference. TOS of FIG 2 is comprised of elements causing red, yellow and blue light to be blended by TIR and are refracted through exit faces EX as blended as rays PRYB.

Rays PR may be refracted in scattered or directed patterns. Tapered optical structures provide a means from distributing relatively even brightness along their length. In this and other configurations multiple or single LEDs projecting light into an optical device for transmission or diffusion may be of singular or multiple colors.

FIG 2A illustrates a means for blending light that is similar in structure and function to The means illustrated in FIG 2 differing in that FIG 2A is comprised of two sections S1 and SL which expands the length of even light distribution.

FIG 2B is a graphic representation of an optical structure similar to that shown in FIG 2A having a single LED at each end LED YL and LED YR. In this configuration, LED YL and LED YR may be of similar or different colors.

FIG 2C is a three-dimensional view of a solid or a hollow wedge shaped optical transmission and diffusion device W similar to that shown in FIG 2 although one tapered surface RPL is intentionally reflective while the opposite surface is a prismatic diffuser RF. LEDs LED R, LED Y, LED B project light into the entry face EF of W. Light exits RF as a mix of light from LED R, LED Y and LED B. The sides of W are also intentionally reflective.

FIG 2D is a three-dimensional view of a solid or hollow wedge similar to that shown in FIG 2C with the addition of a prismatic entry face PEF comprised of prisms PRI substantially perpendicular to RF. PRI scatter rays ERB, ERY and ERR from LED B, LED Y and LED R (respectively) along the planar axis PX of W facilitating the blending of light within the wedge. PRI can be replaced with positive or negative cylindrical lenses.

FIG 2E is a three-dimensional view of a solid or hollow wedge similar to that shown in FIG 2C and 2D with the addition of a refractive surface PRF. PRF has linear prisms LP which result in mixed rays RBYR. PRI of FIG 2D has been replaced by negative cylindrical surface ERR.

FIG 2F is a three-dimensional view of a solid or hollow wedge similar to that shown in FIG 2C, 2D and 2E with the addition of having a prismatic surface PRF containing pyramidal prisms PC.

FIG 2G is a sectional view of FIGs 2C, 2D, 2E and 2F illustrating entry ray ER passing through EF, reflecting off RLS and refracted by FF as ray RRYB.

FIG 3 illustrates a matrix or grid ORM comprised of multiple rods or tubes described in FIG 1, 1A and 1B. Each of the tubes or rods ORT can be optically "fed" by either an LED(s) at on end only illustrated by the group of LEDs OE or from both ends by groups OE and OO.

FIG 4 is a three-dimensional view of an optical structure TOM comprised of tapered bars TOSN and TOSP (similar to those described in FIG 2) that are alternately configured along the structure in terms of the direction of their taper. Such a structure (TOM) may be molded from a single glass or plastic structure, in which case light between the bars would be able to pass from one bar to another where the bars are interfaced, or TOM be fabricated by stacked individual bars TOSN and TOSP in which there would be no transfer of light between the faces of the bars. Although FIG 4 shows a single LED of the bars, multiple LEDs can be used, also shown in FIG 2.

FIG 5 is a graphic illustration of a matrix or grid TOM comprised of horizontally tapered rods or bars HOL and HOR and vertically oriented tapered optical rods or bars VOT and VOB. HOL and HOR are alternately configured on the grid in terms of their direction of taper pointing left and right. Similarly, VOT and VOB are alternately configured on the grid, their direction of taper pointing up and down. LEDs, LED R, Y and B are located at the wide end (entry face) of each taper. Although a single LED is shown for each taper, as described before, multiple LEDs of the same or similar colors can be used.

FIG 6 is a three-dimensional illustration of an optical configuration MTS for creating a uniformly illuminated surface EX by projecting illumination from banks of LEDs LED T into entry faces EF through tapered wedges TW. Wedges TW function as described in FIGs 2, 2A, and 2B. Blended light from exist exit face EX as rays CR. EX may be textured or grooved in various ways depending upon the degree of diffusion or directionality of CR that is required. Further detail of the relationship of EX to CR is described in FIGs 2C, 2D, 2E, 2F and 2G. LED S of LED T can be of multiple colors, in which case by manipulating the brightness of individual LEDs the color emanating from EX can be multiple or a single color. LEDs of LED T may also be of a single color.

FIG 6A is a cross-section view of FIG 6 further illustrating a bar TB of tapered optical segments having entry faces EFT through which the light from various color LEDs are projected. LED R projects rays red rays RR, LED Y projects yellow rays RY and LED B

projects blue rays BR. RR, RY and RB are projected through TB and exit EX as combined or mixed color RNPB.

FIG 6B is a three dimensional diagram of an optical system MTS for integrating the illumination of multiple LEDs using the combined principles of FIGS 6, 6A, 2A and 2B. For graphic purposes, two double rows of LEDs are illustrated: LEDSL and LEDSR of which LED L and LED R are shown to project light into entry faces EL and SR respectively and leaving the portion MTSD of entry face EX as rays RLRR which are the mixed light from LED SL and LED SR.

FIG 6C – is a sectional view of 6B.

FIG 7 is a graphic diagram illustrating a group of LEDs, LED R, LED Y and LED B projecting rays though a prismatic plate PP (containing an entry face EX comprised of either linear prisms) which divides and alters the direction of projected rays RR, RY and RB which exit PP through exit face EF as combined rays ray B.
FIG 7A is a three-dimensional diagram of a row of LEDs projecting into a lens LL comprised of an entry face EF having linear prisms LP or positive vertical cylinder lenses at substantially 90 degrees to the focusing aspheric or spherical surface CS of the exit face EX. Rays from LEDs CR are combined and widened along the linear axis VA. This is further illustrated by rays LR crossing at a wide angle LA and rays VR crossing at a narrow angle VA. This process allows for a narrow band of mixed color illumination from a linear projection device.

FIG 7B is a cross-sectional view of FIG 7A showing multiple rows of LEDs MRL projecting through LL.

FIG 8 is a plane-view of a disk-like optical configuration DO having a ring of LEDs LER of alternating colors, typically LED R, LED Y and LED B, projecting into and through a refracting prismatic ring comprised of linear prisms that are oriented perpendicular to the

disks' surface and onto the refractive ring RER. Rays from LED R LED Y and LED B, respectively RR, RY and RB, are mixed by PR and are reflected by RER as rays RRYB.

FIG 8A is a cross-sectional view of DO further illustrating the function of the combined elements LER, PR and RER. In some of the configurations PR is the entry face of a solid transparent material and RER reflects via T.I.R (total internal reflection). In this configuration, the faces of the above-mentioned ring are polished surfaces RS and FS which contain the dispersion RRYB by T.I.R., and allows RRYB to exit through area EX. In other configurations PR is a prismatic ring and RER is a separate reflector. In order to maintain a thin cross-section of DO, when PR and RER are separate elements, RS and FS can be reflective to contain the spread of RRYB.

FIG 8B is a cross-sectional view of a disk-like optical configuration having a ring of LEDs LER surrounded by a prismatic ring (as in FIG 8) surrounded by disk TR having a tapered cross-section one face RS being reflective and one face RFS being refractive. The function of TR is similar to that described in FIG 6A and 6B producing mixed and diffused light RRYB.

FIG 8C is a cross-sectional view of ring of LEDs LER surrounded by a refractive ring PR (the function of both previously described) further surrounded by a ring refracted TPR. Having wedge prism cross-section TAE wide part of the wedge mounted on or within proximity to an architectural surface as light leaving PR is bent and onto AS by TPR forming a ring of light on AS.

FIG 8D is a graphic representation of an optical system comprised of PR and LER within square plate PS rather than a round disk shown in FIGs 8, 8A and 8B.

FIG 8E is a graphic illustration of a series of hexagonal shapes each comprised of an optical system LER/PR/TYP (similar to that describing FIGs 8 and 8A) into hexagonal disks and interlocked within a grid DP. Any geometric shapes such as triangles, squares, hexagons, etc can be used to form such a grid.

FIG 9 is a cross-sectional view of a grid (FIG 9C) of point sources surrounded by lens configurations MRL which are similar to the lens configuration shown in FIG 2 of my U.S. Patent No. 6,361,191, the substance of which is incorporated herein by reference. Lenses MRL are mounted to a reflective surface RS.

FIG 9A is an enlarged view of FIG 9 showing MRL as being integrated with LED point sources LED R and LED Y. Light emitted by LED R or LED Y is projected as canted radial beam CRU from ring lens segment MRLU onto reflected surface RS at acute angle RA and further reflected by RS as rays REF. Ring segment MRLL projects canted radial beam CRL at angle DR REF and CRL of LED R mix with the same beams projected by LED Y and LED B forming a uniform field UF of projected light.

FIG 9B is an optical light emitting structure CI similar to that described in FIGs 9 and 9A with the addition of diffusing surface DS which receives CRU and CRL further mixing and directing UF as SUP. The optical configuration of CP can provide a uniformly illuminated panel, and when the brightness of LED R, LED y and LED B are controlled independently by an electrical means, the color and hue of SUP can be changeable and variable. The combination of MRL, RS, DS as an individual illustration means is disclosed in Fig. 3 and the accompanying text of my U.S. Patent No. 6,033,092, the substance of which is incorporated herein by reference.

FIG 9C is a graphic representation of a plan view of FIGs 9, 9A and 9B illustrating a geometric pattern of LEDs R,Y and B mounted within a panel LEDP. The pattern consists of substantially equilateral groupings of LEDs, which in the case of using three colors of LEDS (for instance red, yellow and blue) each color is surrounded by the other two colors alternately forming a hexagon H-1.

FIG 10 is a three-dimensional diagram of a grid IG comprised of similar panel-type sections LC, LC2, LC3 and LC4. LC1 is a typical panel having a pyramidal reflective surface TRS in which a blind hole OH is at the apex of the pyramid. Within OH is an

LED (surrounded by a ring collimated lens RL). A refractive surface FDLS is opposite to this and is substantially similar in function and design as described in RF of FIGs 2A, 2B, 2C, 2D, 2E, 2G and EX of FIGs 6, 6A and 6B.

FIG 10A is a diagram representing a partial cross-section of 2 LC panels of FIG 10. LED 1 is surrounded by ring collimation lens ARL which projects a radial beam RB through entry face EX of hole OH. RB is reflected by TRS as rays RR onto FDLS. PC is the dividing face which borders panels LC. PC is a window when LC is a single mold, or partially reflective when LC is a separate component.

FIG 10B is a diagram differing from that of 10A in that ARL of FIG 10A has been replaced by collimating ring COR (which can be the enclosure for light source LED 1). COR is comprised of a LED 1 surrounded by a collimating ring section RLC and a parabolic reflecting section PPC. COR is further described in my U.S. Patent No. 5,897,201 the substance of which is incorporated herein by reference.

FIG 10C is a cross-section of a grid as illustrated in FIGs 10, 10A and 10B having a sequential repeating colors LEDs. IG of FIG 19 may be comprised of triangular panels about a triangulated grid shown in FIG 9C or other polyhedinal shapes such as hexagons shown in FIG 8E.

FIG 11 is a cross-sectional diagram of a light-emitting optical structure containing a light source LED R. LED R is comprised of multiple LEDs bundled in a tube or rod configuration. The function of LOS is described as an alternate to the light source and collimation means, and is described in my U.S. Patent No. 6,540,382, the substance of which is incorporated herein by reference.

FIG 11A is a cross-sectional diagram of a tubular structure LED TR comprised of alternating LEDs, LED R, LED Y and LED B. LED R, LED Y and LED B have internal means of collimation.

FIG 11B is a cross-section of a bundle of LEDs filling the cross-section of a rod LED R.

Fig. 1B illustrates a similar optical configuration as in Figs. 1 and 1A differing in that both ends of the optical transmission rods are fed by LEDs, LEDR, LEDY and LEDB.

Fig. 6D is an illuminating panel PL, which is substantially rectangular and is comprised of four sections SS, each having a tapered cross section SA, which is similar to those shown in Figs. 2C, 2D,2E, 2F and 2G. SS combine to form a single integrated plane surrounded by banks of LEDs LEB, LEB2, LEB3 and LEB4, the functions of mixing and refracting light from LEDs REDR, LEDY and LEDB are explained in connection with Figs. 2C, 2D, 2E, 2F and 2G.

It will now be apparent to those skilled in the art that other embodiments, improvements, details, and uses can be made consistent with the letter and spirit of the foregoing disclosure and within the scope of this patent, which is limited only by the following claims, construed in accordance with the patent law, including the doctrine of equivalents.